BMDE 610: Functional Neuroimaging Fusion

COURSE OUTLINE

Lectures
Class time: Friday 8h30– 11h30
Class room: ONLINE
Zoom link lectures: https://mcgill.zoom.us/j/84540763428
Meeting ID lectures: 845 4076 3428

All course materials, slides and zoom videos will be posted online on Mycourses

Instructor
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Prerequisite:
ECSE 305, MATH 223 or equivalent. The main requisites consist in being familiar with some notion of linear algebra (matrix multiplication, inversion) and statistics (Gaussian distribution, Bayes’ rules)

Course description

Learning Outcomes
To gain sufficient knowledge regarding the complementaries and limitations of functional exploration techniques of brain activity: (i) electrophysiology: measuring neuronal bio-electrical activity with Electro- or Magneto-EncephaloGraphy (EEG vs MEG), (ii) hemodynamic processes: measuring indirectly the blood response to an activated brain region using functional Magnetic Resonance Imaging (fMRI) or Near Infra Red Spectroscopy (NIRS)

To understand the concepts of ill-posed inverse problem and multimodal fusion

To be able to critically assess most studies published in this field.

To be able to interpret EEG/MEG source localization results, fMRI results, NIRS results

To be able to chose a particular method/software when having to analyse such data

To be able to assess whether a new methodology was appropriately validated.
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Evaluation Procedure

(1) Mid-term exam: Feb 26th 2021 (Subject to change), 8h30:9h30, (30%)
   • Understanding of important concepts
   • Interpreting source localization results

(2) Assignment 1: March 19th 2021 (15%):
   • Implementing and testing source localization using Brainstorm software

(3) Participation (attendance): 5%

(4) Final Project: abstract (5%) report (20%) oral presentation (25%):
   • Detailed analysis of an article or a particular application of neuroimaging data fusion, with specific emphasis on validation methodology. The objective of the project is to present in details, the added value of using data fusion in a specific application context. A clear and detailed understanding of the proposed methodology is expected

   Abstract (5%) – 500 words: March 12th 2021
   Oral presentation (25%): April 13th/16th 2021
   Report (20%) – (8 pages, Times New Roman, 12pts): April 23rd 2021

McGill policy statements

“McGill University values academic integrity. Therefore, all students must understand the meaning and consequences of cheating, plagiarism and other academic offences under the Code of Student Conduct and Disciplinary Procedures” (see www.mcgill.ca/students/srr/honest/ for more information). (approved by Senate on 29 January 2003)

“In accord with McGill University’s Charter of Students’ Rights, students in this course have the right to submit in English or in French any written work that is to be graded.” (approved by Senate on 21 January 2009 - see also the section in this document on Assignments and evaluation.)
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Proposed Outline (subject to small modifications to be updated on Mycourses)

<table>
<thead>
<tr>
<th>Week</th>
<th>Content</th>
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| Jan 8th    | W1: 8h30-10h: Introduction  
W1: 10h-11h30: Basic principles in MEG/EEG, in fMRI/NIRS                                                                                   |
| Jan 22nd   | W2: 8h30-9h30: Important concepts: Multimodal fusion  
W2: 9h30-10h30: Important concepts: Validation Methodology  
W2: 10h30-11h30: Equivalent current dipoles                                                                                                   |
| Jan 29th   | W3: 8h30-11h30: Generative models (forward pb): EEG/MEG                                                                                   |
| Feb 5th    | W4: 8h30-10h: Dipole scanning approaches (MUSIC, Beamformer)  
W4: 10h-11h30: Distributed models 1: Min Norm, LORETA, L1                                                                                   |
| Feb 12th   | W5: 8h30-10h: Time-Frequency analysis of EEG/MEG (J.M. Lina)  
W5: 10h-11h30: Time-Frequency based source localization (J.M.Lina)                                                                            |
| Feb 19th   | W6: 8h30-10h: Distributed models 2: anatomical MRI constraints  
W6: 10h-11h30: Distributed models 3: Hierarchical Bayesian Models                                                                             |
| Feb 26th   | W7: 8h30-10h: Atlas of intracranial EEG data (B. Frauscher)  
W7: 10h-11h30: Simultaneous EEG/MRI in epilepsy (J. Gotman)                                                                                  |
| March 5th  | W8: 8h30-9h30: Midterm exam  
W8: 9h30-10h30: Distributed models 4: MEM, Fusion EEG/MEG  
W8: 10h30-11h30: Brainstorm software training                                                                                               |
| March 12th | W9 No class, reading week                                                                                                               |
| March 19th | W10: 8h30-10h: fMRI analysis: Study design, GLM  
W10: 10h-11h30: Hierarchical Bayesian Models, group studies                                                                                   |
| March 26th | W11: 8h30-10h: fMRI analysis: Multiple comparison  
W11: 10h-11h30: fMRI analysis: functional connectivity (B. Bernhardt)                                                                             |
| April 2nd  | W12: 10h-11h30: Exploring oscillatory brain networks with MEG and intracranial EEG (K. Jerbi)                                                                 |
| April 9th  | No class Easter Friday                                                                                                                  |
| April 13th | W13: 8h30-10h: NIRS analysis: GLM, deconvolution, inverse problem  
W13: 10h-11h30: Comparative / Constrained Fusion                                                                                           |
| April 16th | W14: 8h30-10h: Symmetrical Fusion /Generative model  
W14: 10h-11h30: Final projects / Oral presentations                                                                                         |
| April 16th | W14: 9h-12h: Final projects / Oral presentations                                                                                         |